TOPOLOGY BASED SURFACE MESHING AND MORPHING

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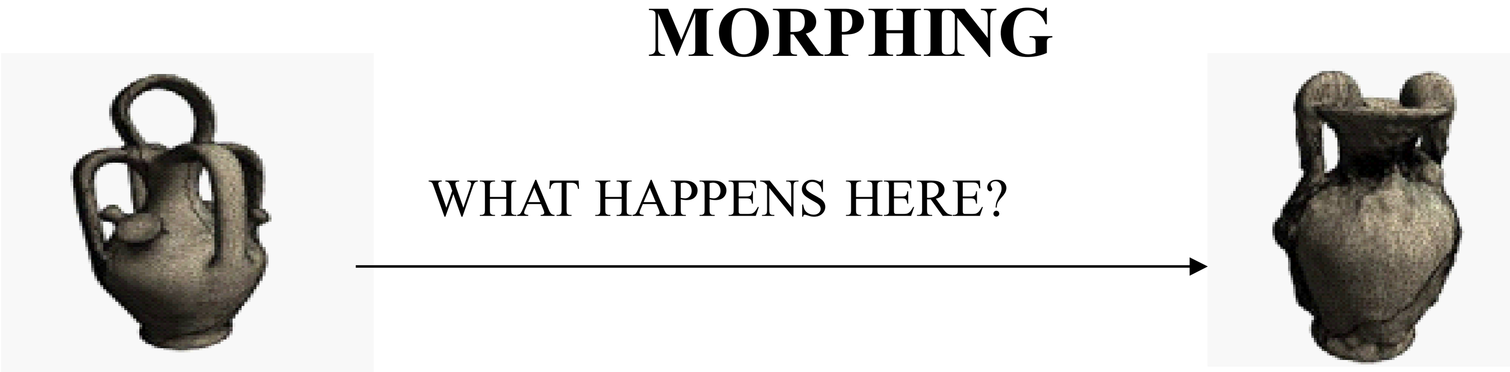
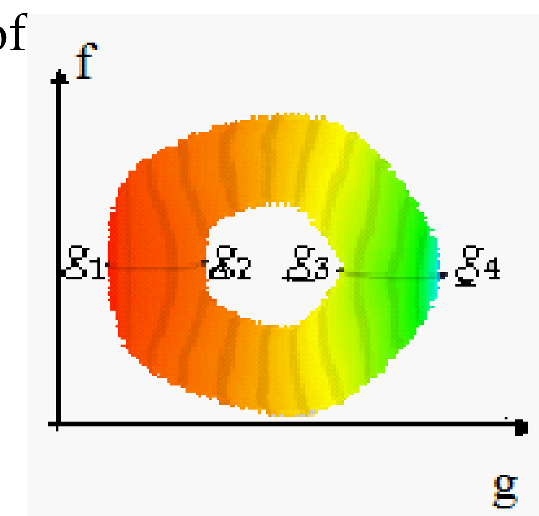
MORPHING

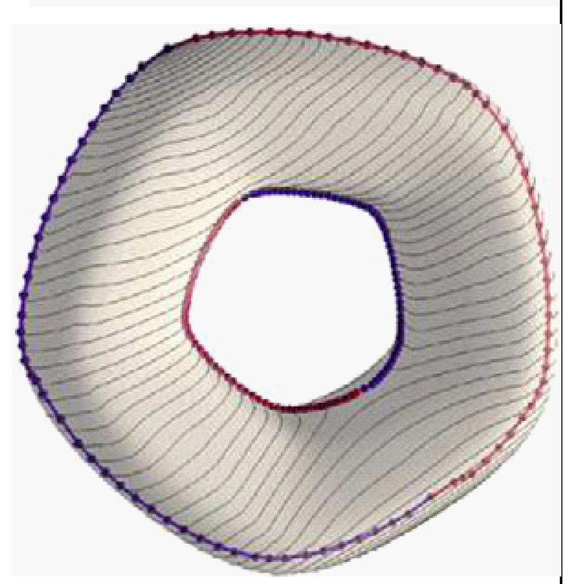


Morphing is a seamless transition from one image to the other, used in animation and motion pictures.

Mesh Parameterization used in this process is a fundamental tool used for domain remeshing. In case of 2-manifolds for example, most approaches require that the input mesh be cut into one or more open disks prior to computing a parameterization. When it is cut into single disk., it gives way to intrinsic distortions and when cut into multiple disks, the resulting parameterization is not globalized. Hence a novel approach to parameterize 2-manifold meshes of arbitrary genus to a standard domain by defining two independent piecewise linear Morse functions on the mesh is proposed.

1. Mesh Parameterization: Mapping a mesh onto another, of similar topology. We address the harder problem of mapping meshes from different genus. We define 2 piece-wise Morse functions 'f' and 'g' on each mesh. The Jacobi set of these two functions is derived , which is not minimal. A closed loop of edges is plotted and simplifying them until we reach a desired Jacobi set. This set would have N+1 closed loops for a mesh of genus N. This Jacobi set can divide each mesh into topologically equivalent patches.

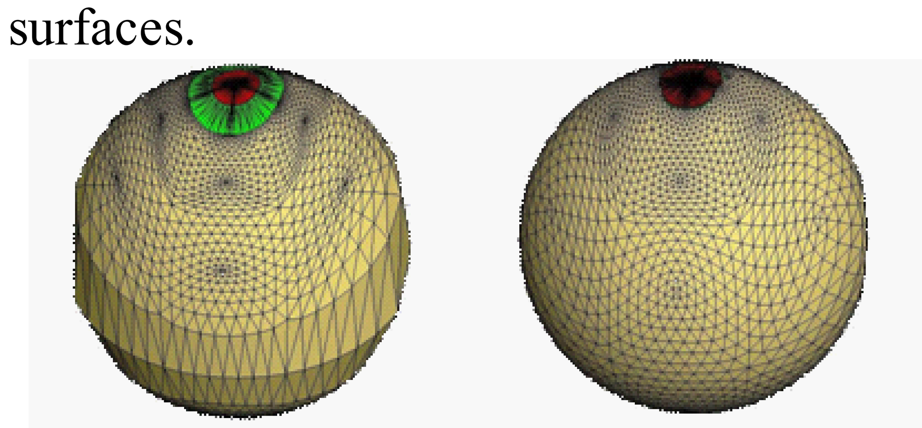




A minimal Jacobi set partitions M into topologically equivalent regions. In this image red denotes maximum values and blue denotes minimal values on a level set Component

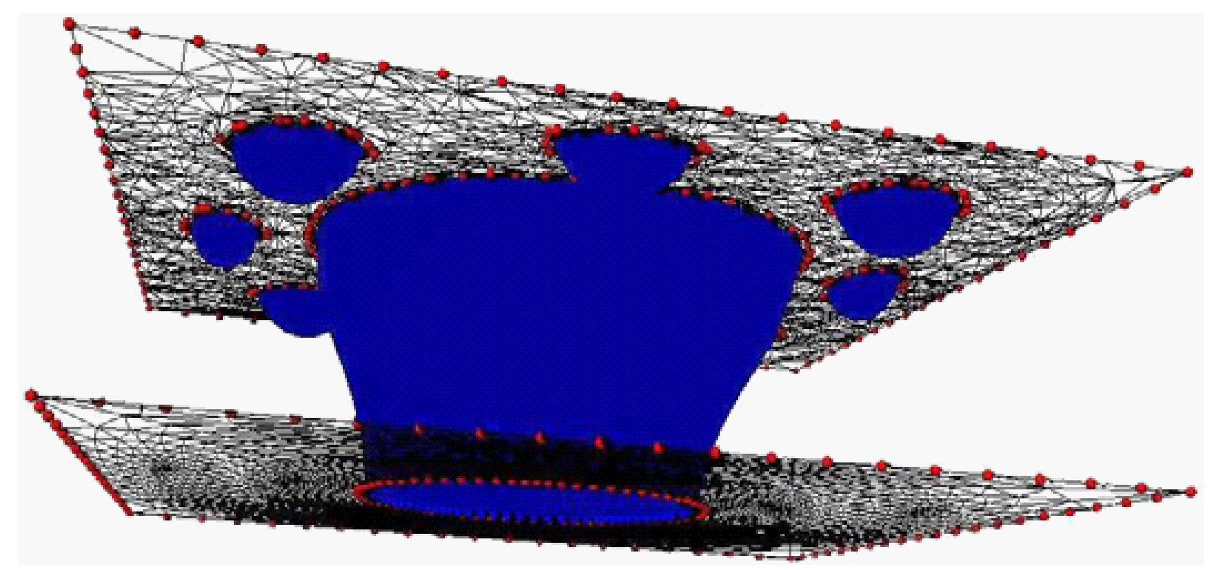
2. Alignment:

In order to make a morph between two meshes look natural, we aimed at improving the alignment of the meshes at a finer level, using a non-linear optimization process. Assigning energy value to each vertex on the mesh and using a nonlinear solver, to adjust the parameterization in order to minimize the distortion between the two surfaces.



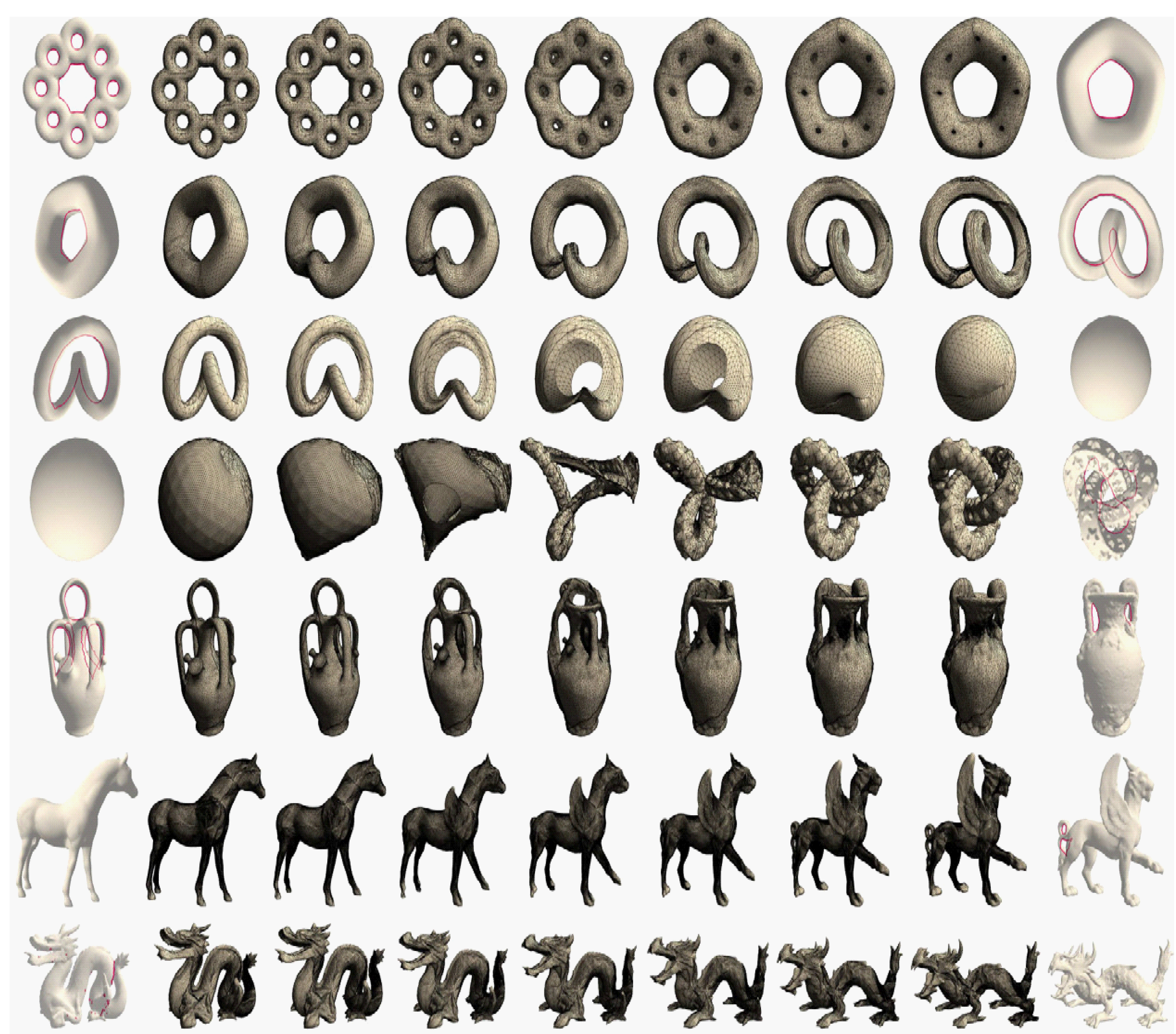
3. Morphing:

We have two topologically equivalent patches for each mesh, of which one mesh is the source and the other is the target. At this point a meta-mesh containing the positional information of both the source and the target mesh is created. At any given time-step, the morphed image of the two meshes is the linear interpolation of the positional attributes associated with the source and target mesh.



A 2D variational implicit function used to solve the morph sequence between two objects.

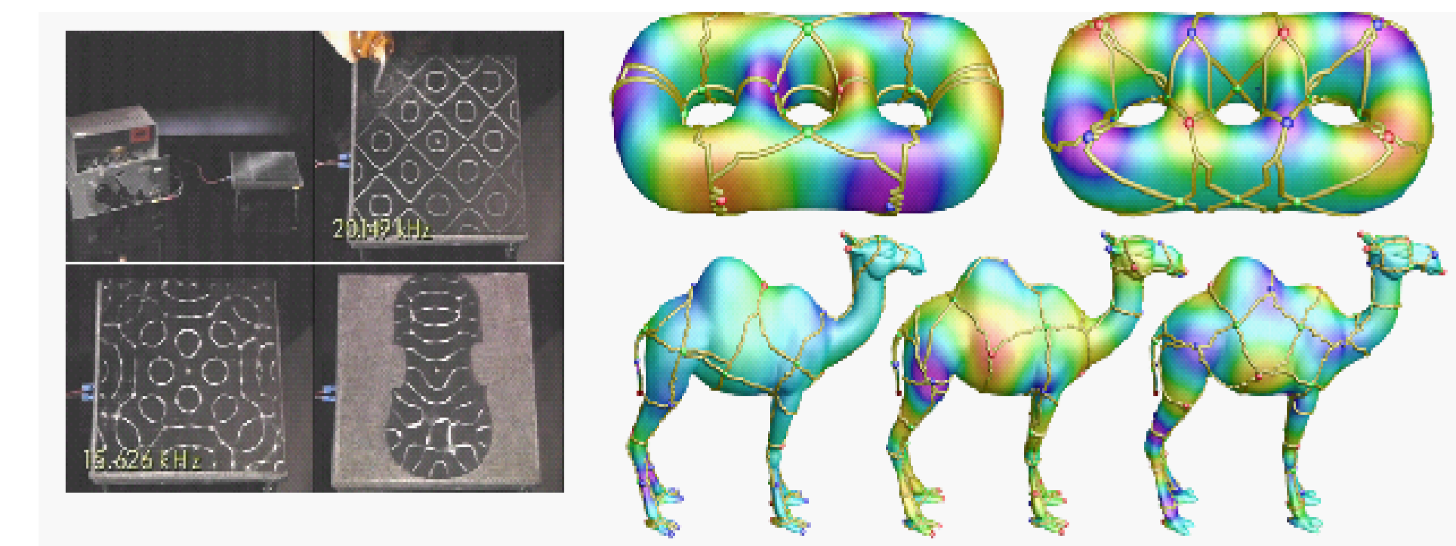
Results:



SPECTRAL SURFACE QUADRANGULATION

Many applications prefer quadrilateral meshes over triangulated ones (CFD, CAD/CAM, etc.) All-quad meshes have numerical advantages in simulations, can be directly converted into tensor product splines, and are easier to texture-map. The goal is to compute a quadrangulation with well-shaped (internal angles close to 90º) elements and few extraordinary (non valence four) points.

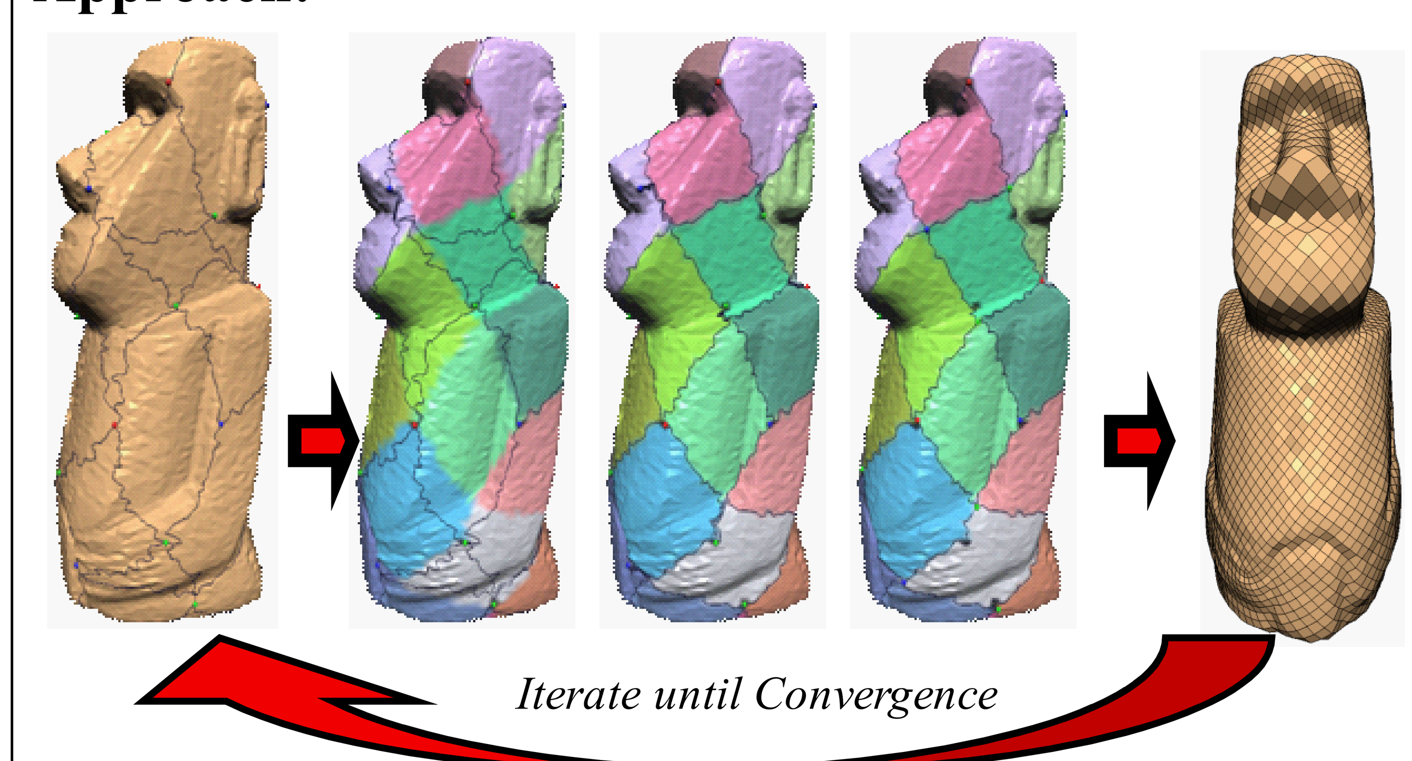
Laplacian Eigen Functions:



Shapes vibrate following their natural frequency spectrum

Eigen functions describe the spectrum for arbitrary shapes

Approach:



Results: